

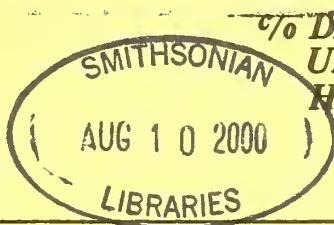
NEWSLETTER

of the

Hawaiian Botanical Society



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DEPARTMENT OF BOTANY
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PRINCIPAL PAPER

K A H O O L A W E

By

Sheila B. Myhre^{1/}

The intent of this paper is to show the effect of introduced animals and plants on the indigenous vegetation of the island of Kahoolawe. The period covered is from the 18th century to the present. As Kahoolawe is under the control of the United States Navy and off-limits to visitors, all information included in this report is based on literature, published or on file, and from personal accounts of people who have been on the island.

Location: Kahoolawe is one of the Hawaiian islands. It is 6-3/4 miles to the southwest of Maui, and in the lee of Maui's 10,000-foot volcano, Haleakala.

Geophysical Features: Kahoolawe is eighth in size of the Hawaiian Islands. It is an extinct shield volcano, 11 miles long, 6 miles wide and contains 28,000 acres. Maximum elevation is 1,477 feet. There are high cliffs to the east and south and rocky terrain cut by steep gulches to the north. A gradual slope from east to west is broken by five small volcanic domes. Two craters, Lua Makika and Lua Kealialalo, serve as temporary natural water reservoirs during rainy seasons. The most distinctive feature is the north central area of red hardpan from which in the constant trade winds a cloud of red dust is blown out to sea. Hanakanaea Bay, to the west, and Kuheia Bay, to the north, form natural harbors.

Weather: Kahoolawe is the windiest Hawaiian island because the trade winds deflected around Haleakala sweep over it with great force. Haleakala robs the moisture from clouds to the northeast, and Kahoolawe depends on Kona storms for its rain (Stearns, 1940). Rainfall recorded on the island has ranged from 8 to 27

^{1/} Paper prepared for course in Natural History, University of Hawaii.



inches per year (Zschokke, 1932 and Stearns, 1940). Fresh water is available only in the rainy season, in the two craters and formerly, in tanks and cisterns. Wells yield brackish water with a high salt content (Stearns, 1940).

History: It is difficult to determine exactly what native vegetation was originally present on Kahoolawe, since the first written records from the 18th century are not too specific. There is little written information from old Hawaiians about prehistoric Kahoolawe, and most accounts available were limited for the most part to cultivated plants. David Malo says: "Kahoolawe was made up of kula land, and the principal vegetable was the potato, besides which yams and sugar cane were produced, but no taro." (Malo, 1951). William Ellis noted that: "It is low, and almost destitute of every kind of shrub or verdure, excepting a species of coarse grass" (Ellis, 1969). Adventurer Perkins, in 1850, reported trunks of akoko (akoko) trees, with bark chewed by goats, and some stunted wiliwili (Restarick, 1931). In 1857, the following plants were found: ohe, tree tobacco, laau kau, calabash gourd vine, sugar cane, kalamalo and pilo grass, umealo (Fox-tail), kukaepuaa, kikania, a few pualele and of small trees; akoko, aalii, sandalwood and wiliwili (Nahaolelua and Richardson, 1857). About six months later another report mentioned natives growing sugar cane, melons, potatoes and pumpkins on the highest part of the island, where the soil was said to be very good (Allen, 1938).

Of introduced fauna, we can be more exact about arrivals. Captain Cook's voyages left goats on Niihau (Bryan, W., 1915), and Vancouver was credited with giving goats to a Maui chief, who sent some to Kahoolawe to multiply (Kahoolawe, Pacific Commercial Advertiser, 1912). Perkins was the first to notice damage done by goats to the bark of the akoko trees (Restarick, 1931). In 1858, wild dogs, pigs and goats were reported (Allen, 1938). By 1859, several thousand sheep had arrived (Stearns, 1940) and William Webster said there was possible pasturage for 10,000 sheep and 5,000 goats (Hollingsworth, 1938). Prior to this period, Kahoolawe had been used as a semi-permanent fishing settlement and as a penal colony (McAllister, 1933). In 1858, the first lease to Kahoolawe was sold to R. C. Wyllie and the island became a sheep ranch (Polynesian, 1858). In 1863, Elisha Allen purchased a 50-year lease and continued raising sheep, and when King Kalakaua visited Kahoolawe in 1876, he reported 20,000 sheep, 10 horses, and that the island was only fit for grazing (Advertiser, 1876). Sheep ranching was continued until 1880, when A. D. Courtney and W. H. Cummins assumed the lease and planned to replace the 2,000 goats and 1,000 sheep they found with cattle, thus introducing cattle to Kahoolawe for the first time (Hawaiian Gazette, 1881). The fourth lessees had 900 cattle and 12,000 sheep (Judd, 1917). From 1901, the island was leased as a sugar plantation, a sheep ranch (Pacific Commercial Advertiser, 1903), and in 1906, again leased for sheep ranching. Soon after this, Kahoolawe came to the attention of the Territorial Legislature, who passed a resolution stating that Kahoolawe must not be leased again, the animals should all be removed and the vegetation restored. On August 25, 1910, Governor Frear proclaimed Kahoolawe a forest reserve (Board of Agriculture and Forestry, 1910). By this time, the damage to the island and its vegetation was very apparent. A report of the Board of Commissioners of Agriculture and Forestry stated that Kahoolawe was non-water bearing and contained considerable areas not covered with vegetation. They planned to reclaim the island by planting a new vegetation cover to replace the former one (Board of Agriculture and Forestry, 1910). C. S. Judd wrote:

"The innumerable sheep and goats cropped the grass and other herbage so closely that the sod cover was broken. This gave the entering wedge for the wind to exert its influence on the light top soil. This unprotected and exposed soil could not stand the force of the strong trade wind but was lifted little by little and carried southwest across the island many miles out to sea in a great

red cloud. In this manner the top of the island which was once covered with from four to eight feet of good soil has been reduced largely to hardpan." (Judd, 1917)

Governor Frear decided, after a visit to Kahoolawe, that reclamation should start immediately; that the lease should be terminated and all animals removed (Pacific Commercial Advertiser, 1912). Eben Low's lease ran until 1913, but in return for remission of back rent due, Low agreed to give up his lease and to remove his stock within a year (Board of Agriculture and Forestry, 1910). Of primary importance to reclamation was the prompt and complete removal of all goats, sheep and other livestock, to give the remaining vegetation a chance to recover (Pacific Commercial Advertiser, 1912). Removal of the sheep, wild goats and Low proved to be a difficult task. He was given many extensions of time and did remove many sheep and goats, but by 1917, his men were still working on the island, and there were still many herds of sheep and goats there (Board of Agriculture and Forestry, 1910-1917).

Meanwhile, in 1913, Charles N. Forbes of the Bishop Museum visited Kahoolawe to record its flora. He arrived during an unusually long drought period and found few plants to observe and collect. He noted 16 native plants and 15 introduced species. The most common shrub found was the tree tobacco (Nicotiana glauca), probably because the animals wouldn't eat it. Other vegetation had suffered considerably from the goats and sheep; algaroba (Prosopis juliflora) had been girdled by goats and few shore plants were seen, having apparently been eaten. The southern and eastern ends of the island were covered with dried pili grass (Heteropogon contortus) and the wiliwili (Erythrina monosperma) was the only surviving indigenous tree seen. In addition to vegetation previously mentioned, Forbes said puu keawe (Cyathodes Tameiameia), ohe (Reynoldsia sandwicensis) and naio (Myporum sandsicense) had been seen in the previous 25 years. He believed that other low elevation dry land plants, such as Santalum ellipticum, Wikstroemia, Pandanus odoratissimus and Metrosideros polymorpha must have grown there at some time. He noted "...to any one interested in the many factors at work changing the character of an indigenous flora there is much of interest." (Forbes, 1913)

Between 1900 and 1918, many new plants were introduced to Kahoolawe. Algaroba (Prosopis juliflora) was planted in 1900 (Stearns, 1940). Later Eucalyptus, Ironwoods, cactus (Opuntia tuna) and spineless cactus, candle and grape trees, Foreign koa, coconuts, Grevillea robusta and paspalum grass were planted (Board of Agriculture and Forestry, 1915-1918).

By 1918, it was obvious that as a forest reserve, Kahoolawe was not being reclaimed or properly utilized. It was turned back to the Commissioner of Public lands, and the new lease provided for immediate extermination of all goats and a limit to the number of cattle or horses to be pastured there. It also provided for enforcement of its terms (Governor Pinkham, 1918). Angus MacPhee, a rancher from Maui, was the successful bidder and began the removal of the goats. Within three years, he had removed 13,100 goats. A fence was built across the island to keep the few remaining goats and sheep confined to the rocky hills of the east side. Five thousand trees, hundreds of pounds of Australian salt bush and grass seed were planted. Harry A. Baldwin of Maui joined MacPhee in partnership in the Kahoolawe Ranch Company and by January of 1941, they had invested \$190,000 in the island (Ashdown, 1947). By 1925, 500 to 600 cattle were grazing on the pili grass-covered lower slopes (Governor Farrington, 1925).

In 1931, E. H. Bryan, Jr., of the Bishop Museum visited Kahoolawe and observed the fauna and flora there. He found only a few native species; Heteropogon contortus,

Sporobolus virginicus, Boerhavia diffusa, Capparis sandwichiana, Erythrina monosperma, Sida fallax, Waltheria Americana, Ipomoea sp., Jacquemontia sandwichensis var. tomentosa, Scaevola frutescens and Lipochaeta bryani, some of which are strand plants not seen by Forbes (he assumed they probably had been present but had been eaten during the drought). Of introduced species, Bryan found 30. Prosopis juliflora, Xanthium strumarium, Atriplex semibaccata, Argemone glauca and Acacia farnesiana were abundant, others were seen in small clumps or sparsely spread on the island. Bryan saw a few sheep and goats, about 100 cattle and horses, about 60 different species of insects, 8 species of birds (none native) including wild turkeys. Water was being carried from Maui because of a drought (Bryan, E., 1931). Neither Forbes nor Bryan found Neraudia kahoolawensis, the only plant named by Hillebrand as endemic to Kahoolawe (Forbes, 1913).

In 1939, Harold Stearns, on a U. S. Geological Survey trip to Kahoolawe, found Australian salt bush (Atriplex semibaccata) and Molasses grass (Melinis minutiflora) had spread widely and were growing on part of the wideswept areas, catching soil and forming mounds of earth and vegetation. Kiawe (Prosopis chilensis) had spread over the lower slopes and was slowly growing into the summit area. He found one guava (Psidium guajaca) shrub, a few Ironwoods (Casuarina equisetifolia), a row of Eucalyptus (with tops killed by wind), some Sisal (probably Agave sisalana), cactus (Opuntia megacantha) and Haole koa (Leucaena glauca), both growing well, a few lantana (Lantana camara var. aculeata), and tree tobacco (Nicotiana glauca). The only indigenous plants he saw were wili-wili trees (Erythrina sanwicensis), a brush of sandalwood (Santalum ellipticum?), a stump of a dark colored native hardwood tree, and a Ti plant (Cordyline terminalis). Pili grass (Heteropogon contortus) was not mentioned in his report but undoubtedly should have been included, since it has been recorded since 1939. Other plants on the island at the time of his visit may also have been omitted; his notes on vegetation were incidental to his study of ground water resources. Otto Degener identified the plants found. Animals that Stearns saw included 500 cattle, 200 wild sheep, 25 wild goats, 17 horses and 3 mules. Two well vegetated fenced areas indicated to him that reclamation of the vegetation could be successful if the livestock were removed (Stearns, 1940).

In December 1941, Kahoolawe was subleased by the United States Navy for target practice. They have had jurisdiction over the island ever since (Moskos, 1968). In 1952, it was noted that more than 1,000 sheep and goats were slowly eating the vegetation (Honolulu Advertiser, 1952). A special land commission reported to Governor Oren Long that while nearly one third of the island carries a good stand of pili grass, nearly all the terrain which could be used for cultivation has been eroded to bare hardpan, which would take hundreds of years of protection from heavy grazing, wind and rain, to become useful soil again (Honolulu Advertiser, 1952). Bob Krauss, after a trip to Kahoolawe in 1958, said the goats, sheep, wild cats, mice, quail and bees were the only permanent residents, and keawe trees and grass the obvious vegetation (Krauss, 1958). In 1961, Dan Davis of the U. S. Geological Survey, joined a Marine water survey team on Kahoolawe. He noted that the whole island looked unusually green after recent heavy rains. He saw Keawe flourishing and numerous weedy plants. The Keawe trees were growing up to 500 to 600 feet elevation, some in lower areas with trunks up to 18 inches in diameter, with a height of twenty-five to thirty feet, those at the higher elevations smaller and shrubbier. The Keawe appears to thrive in the brackish groundwater found on Kahoolawe. A Marine captain told Davis that while goats were numerous they were being killed. He thought a drought had reduced the number of sheep (Davis, 1961). More recently the Navy announced sailors had killed 2,856 goats and 109 wild sheep on Kahoolawe in 1969. They said they are required to keep the number of animals down to 200 to prevent destruction to all the vegetation, by executive order from President Eisenhower, in 1953 (Honolulu Star-Bulletin, 1969).

Conclusions:

At one time Kahoolawe was joined to Maui, Molokai and Lanai (Stearns, 1940), so its pre-Hawaiian vegetation could be expected to be similar to plants found on these islands, particularly in the strand and lowland zones. The prehistoric Hawaiians cultivated some crops there, probably during their occupation of Kahoolawe as a fishing settlement as well as during the later period of exile. While we don't know the exact number of indigenous species of plants originally on the island, we do know that 14 native species had been seen there up to 1913, and 16 native, 15 introduced species were collected by Forbes in 1913. We know goats were on the island before 1858 and sheep in 1859, with cattle added in 1880. William A. Bryan and others have reported the destruction in Hawaii to the forests, their undergrowth, bushes and grasses, by the uncontrolled trampling, grazing and digging of the wild introduced animals in these islands. Their destruction left trees and plants dead or dying and upset the ecology of the land in many places. Kahoolawe was no exception to this. The island was frequently overstocked with animals and during periods of drought the livestock was forced to eat any vegetation they could reach (the one exception was Nicotiana glauca). Kahoolawe has not been freed of grazing animals in historic times and it seems very unlikely it will be in the future. As the native plants were eaten, introduced trees, shrubs and grasses were planted to replace them. Vegetation was chosen to hold the soil, provide wind-breaks, or for livestock feed. No attempt was made to restore the native flora, and by 1939, only 3 indigenous species remained. Kahoolawe Ranch Company had done a good job of replanting the island with introduced plants. Under Navy control, goats and sheep are still grazing over Kahoolawe and vegetation loss and erosion appear to be continuing. Pili grass remains but no information is available on the presence of any other indigenous plants. Algaroba, introduced in 1900, is the principal tree.

Several factors were responsible for the change in flora; first and most important, introduced animals ate or destroyed many of the plants; second, they were replaced by introduced plants which spread over many parts of the island, with no attempt made to replant native Hawaiian vegetation; third, part of the island habitat was changed by wind and rain erosion from deep fertile soil to bare windswept hardpan where few plants could root and survive.

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OOPS!

We regret that the June issue of Newsletter inadvertently misspelled the name of Dr. Adrian Brash, the gracious host of the Summer Foray. It is reported that 65 persons attended the Foray.

June issue, page 11, line 8.--GoUania (not Gouvania).

Same issue, page 16, Abstract. The authors are Hulton B. Wood, Robert A. Merriam, and T. H. Schubert.

EVENTS

The International Biological Program in Hawaii

Within recent months, 25 scientists from the University of Hawaii and the Bishop Museum obtained \$229,000 in research funds from the National Science Foundation, the first installment of a five-year coordinated ecological and evolutionary study of Hawaiian ecosystems and species.

The steering committee is composed of three co-directors, Dr. J. Linsley Gressitt (Entomology, Bishop Museum), Dr. Andrew J. Berger (Zoology, University of Hawaii) and Dr. Dieter Mueller-Dombois (Botany, Univ. of Hawaii). The latter acts also as scientific coordinator.

With the initiation of this project on September 1st of this year, Hawaii has joined the International Biological Program (IBP). So far, 57 nations participate in the IBP, which became effective in 1966. The overall objective of IBP is to search for the biological basis of organic production on a world-wide scale. This includes production of plants and animals and their interactions with man and microorganisms in the quantitative and qualitative sense. The quantitative studies are directed towards the volume, rates and pathways of cycling of organic and inorganic matter in the major natural and cultivated ecosystems of the world.

The Hawaii IBP is aimed at four specific objectives:

1. To determine why some organisms in Hawaii have undergone speciation while some of the most successful have not.
2. To determine why some ecosystems in Hawaii are stable, some fragile.
3. To develop fundamental equations relating the variables contributing to the stability and diversity of ecosystems in Hawaii.
4. To determine the rate of evolution in Hawaii and factors affecting it.

The field approach is to work along previously defined ecosystem transects. The first transects to be studied are along the east flanks of Mauna Kea and Mauna Loa. Later, the study will include other transects on Maui and Kauai.

An important cooperating agency is the National Park Service which has provided a house and laboratory space for the IBP researchers at the headquarters of Hawaii Volcanoes National Park.

Recent Staff Changes

Joined the faculty of Botany, University of Hawaii

Dr. William M. Hiesey (see Proceedings)

Left the faculty of Botany

Dr. A. C. Smith, to U. of Massachusetts

Dr. R. D. Goos, to U. of Rhode Island

Joined the staff of Horticulture

Dr. Charles L. Murdoch -- (turf) from U. of Arkansas

Dr. Ray C. Nishimoto -- (weed control and vegetable physiology)
recent PhD graduate, Purdue U.

Dr. Fred D. Rauch -- (extension specialist in ornamental horticulture)
from Mississippi State U.

New Trail Map for Oahu

The Department of Land and Natural Resources has issued a new trail map which also shows State Parks, Forest Reserves, and hunting areas on Oahu. The reverse side of the map contains descriptive notes about the trails. They are available in the Divisions of Forestry, Parks and Recreation, and Fish and Game. Similar maps are being prepared for all major islands.

Native Plants Revegetating Kipapa Burn

Seven months after a wildfire burned over a 4100-acre area in the Ewa Forest Reserve, several native plants were observed revegetating the area. Plants such as the koa and naupaka kuahiwi were reseeding almost everywhere. Koa seedlings were generally concentrated and at the periphery of the fire-killed parent trees. In some places the koa seedlings were in concentration of 15-20/sq. yd. Naupaka kuahiwi appears everywhere, being most prevalent under the shade of burnt trees.

Iliahi is coming back through root sprouts. Some iliahi are flushing new foliage from shoots on the main boles. Ahakea and a few ohia-ha trees are also putting on a flush of new shoots. Ohia was observed to be sprouting around the root collars of fire-killed trees. Other native species that were fire-killed but not observed in the recovering vegetation are mehame, kopiki, akia, and pukeawe.

Kukui trees confined to the lowlying natural drainages were bypassed by the fire. Other native species may also have perished in the fire and therefore not identified. Exotic plants such as the fireweed, poke weed, clidemia, pluchea, and lantana and grasses are occupying the side rapidly.

--Wesley Wong, Hawaii Division of Forestry
September 29, 1970

Epidemic Decline of Ohia

Recent observations of the rainforests above Hilo indicate epidemic decline and death of ohia trees. The specific cause (or causes) is unknown, but it is hoped that the problem can be investigated in some detail. Robert E. Nelson, Director of the U. S. Forest Service Institute of Pacific Islands Forestry, is seeking Forest Service support for studies.

Meantime, a preliminary survey was made in June 1970. Foresters Wesley Wong and Ed Petteys of the Hawaii Division of Forestry, Pathologists Ivan Buddenhagen and Franklin Laemmlen of the University of Hawaii, and Robert Burgan, U. S. Forest Service, made an aerial reconnaissance and ground examination of affected areas and trees. They found insects and fungi as well as site and weather factors associated with the declining and dead trees. But they could not conclude that the association was significant.

Proposed investigations would try to determine the location, extent, rate of spread and causes of the tree death and determine feasible control measures.

Axis Deer Facts

The Committee on Axis Deer of the Kohala Branch, Amer. Assoc. Univ. Women (Mrs. Ruth M. Stearns, chairman) in Hawai, Hawaii, has prepared a very useful pamphlet on the facts concerning the deer. Copies available on request.

Koa Problem Analysis

Several members of the Botanical Society, as well as about 25 other persons, participated in a seminar on October 9 to consider a research program centered on Acacia koa. Dr. Charles Lamoureux covered the topics of taxonomy and ecology. This seminar was organized by the U. S. Forest Service and led by Paul Scowcroft, Research Forester, who is concentrating his research efforts on Acacia koa. A research problem analysis report is being prepared.

PROCEEDINGS OF THE SOCIETY

The following are not complete minutes--only a few highlights of the meeting held at Agee Hall, October 5, 1970.

- (a) Native Plants Committee established. Objectives are to promote study of native plants, disseminate information about them, encourage their use for ornamental purposes, and update and publish trail guides. Chairman pro-tem is Wayne Gagne, Bishop Museum, who is now preparing a list of plants suitable for dry areas.
- (b) Axis Deer Committee. Beatrice Krauss has resigned as Chairman in order to reduce her total work load. Steve Montgomery has accepted the assignment. He reported that a committee of legislators will look into the matter of proposed introduction of deer to Hawaii Island.
- (c) Membership Committee hopes to revamp its structure, particularly to retain a chairman for a period of several years.
- (d) Plant exchange at the November meeting. Bring your offerings to this always notable event!
- (e) Speaker of the evening, Dr. William M. Hiesey, retired, Carnegie Institution of Washington, Stanford University, California, and Visiting Professor of Botany, U. of H. Topic: Relationships between plants and their environments.

PUBLICATIONS

Ecological Book Club. Box 682, New York 10580. It is operated similar to other subscription book clubs. Members agree to purchase 4 books during an 18-month period at reduced prices. First offerings: Crisis in Eden, \$3.20; Famine 1975!, \$5.00; Road to Ruin, \$4.50; The Hudson River, \$5.75. Bonus book, The Story of our Fruits and Vegetables, reg. price \$3.00. No charge to new subscribers.

New conservation magazine. CATALYST for environmental quality. 274 Madison Ave., New York 10016. \$5.00/year. Vivian Fletcher, Editor.

Recent books

From Springer-Verlag New York Inc., 175 Fifth Ave., New York 10010:

- (a) Analysis of Temperate Forest Ecosystems. 1970. Edited by David E. Ritchie, Research Ecologist, Radiation Ecology Section, Oak Ridge National Laboratory. 300 pages, U. S. \$ 14.50. Volume 1 of Ecological Studies, Analysis and Synthesis to provide world-wide information on approaches to analyzing ecological systems.
- (b) Oecologia. Volumes 4-5 to be published in 1970. U.S. \$ 99.90.
- (c) Principles of Dispersal of Higher Plants. 1969. By L. van der Pijl, Emeritus Professor of Botany, U. of Indonesia, Visiting Professor at U. of Nijmegen. With 26 figures, VII, 154 pages.

From Thomas Nelson (Australia) Ltd., 597 Little Collins St., Melbourne, Australia:

- (a) Eucalypts. 1970. Stan Kelly. Text by G. M. Chippendale and R. D. Johnson. 250 full page color reproductions of accurate, detailed water-colors of flowers, fruits, foliage, and twigs. Brief text lists habitats, characteristics, and common names. Aus \$ 14.58.

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